

1. A system for plasma treating workpieces comprising:
 - a plasma treatment chamber for plasma treating workpieces therein;
 - an infeed table having load and unload ends, said unload end
5 disposed adjacent one end of said plasma treatment chamber, said infeed table capable of serially receiving workpieces one at a time at said load end;
 - an outfeed table having load and unload ends with said load end disposed adjacent an opposite end of said plasma treatment chamber, said outfeed table capable of serially discharging workpieces one at a time from
10 said unload end
 - a load pusher arm located adjacent said infeed table; and
 - an unload pusher arm located adjacent said plasma treatment chamber,
 - said load and unload pusher arms being operated to move
15 workpieces in said plasma treatment chamber in a first direction from said plasma treatment chamber and over said load end of said outfeed table, and to move workpieces on said infeed table in the first direction over said unload end of said infeed table and into said plasma treatment chamber.

2. The system of claim 1 wherein one of said tables further comprises a table transfer system capable of moving each of the workpieces in the first direction.

3. The system of claim 2 wherein said table transfer system further comprises supports capable of supporting a plurality of workpieces in a parallel arrangement on said one of said tables.

4. The system of claim 3 wherein said table transfer system further comprises a workpiece drive adapted to move one of the workpieces across said one of said tables.

5. The system of claim 3 wherein said table transfer system further comprises a pair of rails for guiding the one of the workpieces in the first direction.

6. The system of claim 5 further comprising a bridge element pivotally mounted relative to one end of said pair of rails and having a first position providing a subjacent support for the one of the workpieces between said one of said tables and said plasma treatment chamber.

7. The system of claim 5 wherein one rail is mounted to be releasably securable at a desired position with respect to another rail.

8. The system of claim 5 wherein said table transfer system further comprises a roller rotatably connected to one of said rails, said roller having a peripheral surface adapted to support the one of the workpieces on a lower surface adjacent a lateral edge thereof.

9. The system of claim 8 wherein said table transfer system further comprises a roller drive operatively connectable with said roller on said one of said rails to cause said roller to transport the one of the workpieces across said one of said tables.

10. The system of claim 9 wherein said table transfer system further comprises a roller rotatably connected to each of said rails, said rollers having respective peripheral surfaces adapted to support the one of the workpieces on a lower surface adjacent opposed lateral edges thereof, and said roller
5 drive is operatively connectable with said rollers to cause said rollers to transport the one of the workpieces across said one of said tables.

11. The system of claim 9 wherein said table transfer system further comprises a pair of rollers rotatably connected to said one of said rails, said rollers having respective peripheral surfaces adapted to support the one of the workpieces on a lower surface adjacent a lateral edge thereof, and said roller
5 drive is operatively connectable with said rollers to cause said rollers to transport the one of the workpieces across said one of said tables.

12. The system of claim 11 wherein said table transfer system further comprises a fixed support arranged between said pair of rollers, said fixed support having an upper surface for supporting the one of the workpieces on said lower surface adjacent said lateral edge.

13. The system of claim 10 wherein said roller drive further comprises a drive belt movable into and out of contact with said roller on one of said rails to rotate said roller and transport the one of the workpieces between said pair of rails and across said one of said tables.

14. The system of claim 10 wherein said table transfer system further comprises a pair of rollers rotatably connected to each of said rails, each pair of rollers having respective peripheral surfaces adapted to support the one of the workpieces on a lower surface adjacent a lateral edge thereof, and said roller drive is operatively connectable with each pair of rollers to cause said rollers to transport the one of the workpieces across said one of said tables.

15. The system of claim 14 wherein said roller drive further comprises a pair of drive belts, each of said pair of drive belts being movable in unison into and out of contact with a different one of said pair of rollers, said pair of drive belts being operable to simultaneously rotate said rollers and transport the one of the plurality of workpieces between said pair of rails and across said one of said tables.

16. The system of claim 15 wherein said table transfer system further comprises a pair of drive belts, one of said pair of drive belts is mounted to be movable in a second direction substantially perpendicular to the first direction and releasably securable at a desired position.

17. The system of claim 15 wherein said table transfer system further comprises a first motor operatively connectable to said pair of drive belts.

18. The system of claim 3 wherein said table transfer system further comprises a plurality of rails for guiding the plurality of workpieces in the first direction.

19. The system of claim 18 wherein said table transfer system further comprises a rail transfer system for moving said plurality of pairs of rails in a second direction substantially perpendicular to the first direction.

20. The system of claim 19 further comprising a rail drive operatively connected to said rail transfer system and capable of moving each pair of said plurality of pairs of rails to a first position adapted to be aligned with a workpiece handler disposed adjacent an end of said one of said tables.

21. The system of claim 20 wherein one rail of each pair of said plurality of pairs of rails is mounted to be movable in the second direction and releasably securable at a desired position with respect to another rail of each pair of said plurality of pairs of rails.

22. The system of claim 20 wherein each rail of each pair of said plurality of pairs of rails is mounted to be movable in the second direction and releasably securable at a desired position.

23. The system of claim 13 wherein one of said rails of each pair of rails has a pair of opposed pincher rollers adjacent one end of said one of said pair of rails.

24. The system of claim 13 wherein each of said rails of each pair of rails has a pair of opposed pincher rollers adjacent one end of said one of said pair of rails.

25. The system of claim 18 further comprising a bridge element pivotally mounted relative to one end of each of said plurality of pairs of rails and having a first position providing a subjacent support for the plurality of workpieces between said one of said tables and said plasma treatment chamber.

26. The system of claim 25 further comprising a pair of bridge elements pivotally mounted relative to one end of each of the said plurality of pairs of rails.

27. The system of claim 1 wherein one of said tables further comprises:

a first drive adapted to move each of the plurality of workpieces in the first direction;

a plurality of rails adapted to support a like plurality of workpieces in a parallel arrangement;

a second drive adapted to move said plurality of rails in a second direction substantially perpendicular to the first direction; and

at least one of the plurality of rails being movable with respect to another of said plurality of rails through a displacement of about 0.625-6 inches.

28. The system of claim 27 wherein said plurality of workpiece supports comprises about seven rails adapted to support about six workpieces aligned in parallel on said one of said tables.

29. The system of claim 27 further comprising a control in electrical communication with said first and second drives to operate said drives in accordance with a desired cycle of operation.

30. A system for plasma treating workpieces comprising:
 a plasma treatment chamber for plasma treating workpieces therein;

an infeed table having load and unload ends with said unload
 5 end disposed adjacent one end of said plasma treatment chamber, said infeed table serially receiving workpieces one at a time at said load end;

an outfeed table having load and unload ends with said load end
 disposed adjacent an opposite end of said plasma treatment chamber, said
 10 outfeed table serially discharging workpieces one at a time from said unload end;

a carriage;

a load pusher arm mounted on said carriage and located
 adjacent said infeed table; and

an unload pusher arm mounted on said carriage and located
 15 adjacent said plasma treatment chamber,

said carriage moving both of said load and unload pusher arms,
 so that workpieces in said plasma treatment chamber are moved together in a
 first direction from said plasma treatment chamber and over said load end of
 said outfeed table, and workpieces on said infeed table are moved together in
 20 the first direction over said unload end of said infeed table and into said
 plasma treatment chamber.

31. The system of claim 30 further comprising a drive operatively connected to said carriage and capable of moving said carriage and said pusher arms in the first direction.

32. The system of claim 31 further comprising an actuator operatively connected between said carriage and one of said pusher arms, said actuator being capable of moving said one of said pusher arms in a direction substantially perpendicular to the first direction, said actuator moving said one of said pusher arms between a first position permitting said one of said pusher arms to be moved over a workpiece on one of said tables and a second position.

33. The system of claim 32 wherein said one of said pusher arms comprises a pusher element adapted to contact a respective workpiece and push the respective workpiece across said one of said tables in response to said one of said pusher arms being in said second position and said drive moving said carriage in the first direction.

34. The system of claim 33 wherein said pusher element is resiliently mounted to said pusher arm.

35. The system of claim 34 further comprising a sensor for detecting relative motion between said pusher element and said pusher arm.

36. The system of claim 35 wherein said sensor produces an output signal in response to said pusher element contacting the respective workpiece and the respective workpiece not moving as said drive moves said carriage in the first direction.

37. The system of claim 29 wherein said load and unload pusher arms are releasably secured to said carriage, thereby permitting said load and unload pusher arms to be secured to said carriage at different locations.

38. A method of moving workpieces to and from a plasma treatment chamber comprising:

providing infeed and outfeed tables adjacent a plasma treatment chamber;

5 storing at least three first workpieces in the plasma treatment chamber;

receiving automatically at least three second workpieces serially, one at a time, onto the infeed table;

10 transferring automatically and simultaneously the first workpieces from the plasma treatment chamber onto the outfeed table, and

the second workpieces from the infeed table into the plasma treatment chamber; and

15 discharging automatically the first workpieces serially, one at a time, from the outfeed table.

39. The method of claim 38 wherein prior to the step of transferring, the method further comprises:

storing the first workpieces in parallel in the plasma treatment chamber; and

5 storing the second workpieces in parallel on the infeed table.

40. The method of claim 38 wherein after the step of transferring, the method further comprises:

storing the first workpieces in parallel on the outfeed table; and

5 storing the second workpieces in parallel in the plasma treatment chamber.

41. A method of moving workpieces to and from a plasma treatment chamber comprising:

providing infeed and outfeed tables adjacent a plasma treatment chamber;

5 storing first workpieces in parallel in the plasma treatment chamber for plasma treating the first workpieces;

receiving automatically second workpieces serially, one at a time, onto the infeed table during a plasma treating of the first workpieces;

storing the second workpieces in parallel on the infeed table;

10 and

transferring simultaneously and in parallel

the first workpieces from the plasma treatment chamber onto the outfeed table, and

15 the second workpieces from the infeed table into the plasma treatment chamber.

42. The method of claim 41 further comprising:

storing the first workpieces in parallel on the outfeed table; and

discharging automatically the first workpieces serially, one at a time, from the outfeed table during a plasma treating of the second

5 workpieces.

43. The method of claim 42 further comprising receiving automatically third workpieces serially, one at a time, onto the infeed table during a plasma treating of the second workpieces.

44. A method of moving workpieces to and from a plasma treatment chamber comprising:

providing infeed and outfeed tables adjacent a plasma treatment chamber;

5 receiving automatically first workpieces serially, one at a time, onto the infeed table;

storing the first workpieces in parallel on the infeed table;

transferring automatically and in parallel the first workpieces from the infeed table into the plasma treatment chamber;

10 receiving automatically second workpieces serially, one at a time, onto the infeed table during plasma treating of the first workpieces;

storing the second workpieces in parallel on the infeed table;

and

15 after plasma treating the first workpieces, transferring simultaneously and in parallel

the first workpieces from the plasma treatment chamber onto the outfeed table, and

the second workpieces from the infeed table into the plasma treatment chamber.

45. The method of claim 44 further comprising:

receiving automatically third workpieces serially, one at a time,
onto the infeed table during plasma treating of the second workpieces;

storing the third workpieces in parallel on the infeed table;

5 discharging automatically the first workpieces serially, one at a
time, from the outfeed table during plasma treating of the second workpieces;
and

after plasma treating the second workpieces, transferring
simultaneously and in parallel

10 the second workpieces from the plasma treatment
chamber onto the outfeed table, and

the third workpieces from the infeed table into the plasma
treatment chamber.

46. The method of claim 44 wherein the step of receiving
automatically first workpieces further comprises:

receiving one of the first workpieces onto the infeed table;

5 moving the one of the first workpieces in a first direction toward
a discharge end of the infeed table;

moving the infeed table to a position aligning a portion of the
infeed table with a workpiece receiving location;

receiving another of the first workpieces onto the infeed table;

and

10 moving the other of the first workpieces in the first direction.

47. The method of claim 46 further comprising moving the infeed
table in a second direction substantially perpendicular to the first direction to a
position aligning a portion of the infeed table with the workpiece receiving
location.

48. The method of claim 46 further comprising stopping motion of the one of the first workpieces prior to moving the infeed table.

49. The method of claim 46 further comprising iterating the step of receiving another of the first workpieces onto the infeed table and moving the other of the first workpieces in the first direction until all of the first workpieces are loaded on the infeed table.

50. The method of claim 44 wherein the step of receiving automatically second workpieces further comprises:

- receiving one of the second workpieces onto the infeed table;
- moving the one of the second workpieces in a first direction
- 5 toward a discharge end of the infeed table;
- moving the infeed table to a position aligning a portion of the infeed table with a workpiece receiving location;
- receiving another of the second workpieces onto the infeed
- table; and
- 10 moving the other of the second workpieces in the first direction.

51. The method of claim 50 further comprising moving the infeed table in a second direction substantially perpendicular to the first direction to a position aligning a portion of the infeed table with the workpiece receiving location.

52. The method of claim 51 further comprising stopping motion of the one of the second workpieces prior to moving the infeed table.

53. The method of claim 50 further comprising iterating the step of receiving another of the second workpieces onto the infeed table and moving the other of the second workpieces in the first direction until all of the second workpieces are loaded on the infeed table.

54. The method of claim 44 wherein after transferring the first workpieces on the outfeed table, the method further comprises:

moving one of the first workpieces in a first direction towards a discharge end of the outfeed table;

5 transferring the one of the first workpieces from the outfeed table;

moving the outfeed table to a position aligning another of the first workpieces with a workpiece discharge position;

10 moving the other of the second workpieces toward the discharge end of the outfeed table; and

transferring the other of the second workpieces from the outfeed table.

55. The method of claim 54 further comprising moving the outfeed table in a second direction substantially perpendicular to the first direction to a position aligning the other of the first workpieces with the workpiece discharge position.

56. The method of claim 54 further comprising stopping motion of the one of the first workpieces prior to moving the outfeed table.

57. The method of claim 54 further comprising iterating the step of receiving another of the first workpieces onto the outfeed table and moving the other of the first workpieces in the first direction until all of the first workpieces are loaded on the outfeed table.

58. The method of claim 44 further comprising:
- lowering first pusher elements to a location immediately adjacent ends of respective second workpieces on the infeed table;
 - lowering second pusher elements to a location immediately adjacent ends of respective first workpieces in the plasma treatment chamber;
 - moving the second pusher element in the first direction towards the outfeed table to move the first workpieces from the plasma treatment chamber onto the outfeed table; and
 - moving the first pusher element in the first direction towards a discharge end of the infeed table to move the second workpieces from the infeed table into the plasma treatment chamber.

59. The method of claim 58 further comprising moving the first and second pusher elements simultaneously in the first direction.

60. The method of claim 58 further comprising moving the first and second pusher elements simultaneously in the first direction and into contact with ends of the respective second and first workpieces and thereafter, continuing to simultaneously move the first and second pusher elements to move the first workpieces from the plasma treatment chamber to the outfeed table and the second workpieces from the infeed table into the plasma treatment chamber.

61. The method of claim 58 further comprising lowering bridge elements between the infeed and outfeed tables and the plasma treatment chamber before continuing to move the first and second pusher arms.

62. The method of claim 59 further comprising:
 stopping motion of the first and second pusher elements in response to the second workpieces being moved into the plasma treatment chamber;
- 5 raising the first pusher element to a location above the second workpieces; and
- continuing to move the first and second pusher elements and the first workpieces in the first direction to continue to move the first workpieces on the outfeed table.

63. The method of claim 62 further comprising stopping motion of the first and second pusher elements in response to the second workpieces being moved to about a center of the plasma treatment chamber.

64. The method of claim 63 further comprising:
 stopping motion of first and second pusher elements in response to the first workpieces being moved onto the outfeed table;
- raising the second pusher element to a location above the
- 5 second workpieces; and
- moving the first and second pusher elements to a location not interfering with an operation of the plasma treatment chamber.

65. The method of claim 64 further comprising moving the first and second pusher elements in a second direction opposite the first direction to a location not interfering with an operation of the plasma treatment chamber.

66. The method of claim 62 further comprising raising the bridge elements between the infeed and outfeed tables and the plasma treatment chamber after continuing to move the first and second pusher elements.

67. A method of treating workpieces with a plasma comprising:
- providing infeed and outfeed tables adjacent a plasma treatment chamber;
 - receiving automatically first workpieces serially, one at a time, onto the infeed table;
 - transferring automatically and in parallel the first workpieces from the infeed table into the plasma treatment chamber;
 - operating the plasma treatment chamber to plasma treat the first workpieces;
 - transferring automatically and in parallel the first workpieces from the plasma treatment chamber onto the outfeed table.

68. A method of treating workpieces with a plasma comprising:
- receiving automatically first workpieces serially, one at a time, onto an infeed table;
 - transferring automatically and in parallel the first workpieces from the infeed table into the plasma treatment chamber;
 - operating the plasma treatment chamber to plasma treat the first workpieces;
 - receiving automatically second workpieces serially, one at a time, onto the infeed table;
 - transferring automatically and in parallel
 - the first workpieces from the plasma treatment chamber onto the outfeed table, and
 - the second workpieces from the infeed table into the plasma treatment chamber; and
 - discharging automatically the first workpieces serially, one at a time, from the outfeed table.